

REMARKS

Claims 1, 2, 5-7, 9-12, 15, and 22-24 were rejected pursuant to 35 U.S.C. §103(a) as unpatentable over Newman (US 6,544,175) in view of Okado (US 5,348,014). Claim 3 was rejected pursuant to 35 U.S.C. § 103(a) as unpatentable over Newman in view of Okado, and further in view of Chiang, et al. (US 5,839,442). Claims 4 and 14 were rejected pursuant to 35 U.S.C. §103(a) as unpatentable over Newman in view of Okado, and further in view of Pflugrath, et al. (US 6,102,863). Claims 16, 17, 20, and 21 were rejected pursuant to 35 U.S.C. §103(a) as unpatentable over Savord (U.S. Patent No. 6,013,032). Claim 18 was indicated as allowable if amended.

Applicant respectfully requests reconsideration of the rejections of claims 1-7, 9-12, 14-17, and 19-24, including independent claims 1, 9, 16 and 22.

Independent claim 1 recites converting the processed signals to a different form appropriate for the ultrasound system, the conversion being in the transducer assembly. Newman and Okado do not disclose these limitations.

Okado is cited for teaching the transducer connector for detachable connection with the case of the ultrasound system (Office Action, page 3; and Okado, col. 3, lines 25-27). Okado is not cited for, and does not disclose that, a conversion to a form appropriate for the ultrasound system after processing from M to a lesser N signals is performed in the transducer assembly.

Newman, like Okado, has a transducer assembly 104 separate from the scanner 114 (Figure 1; col. 3, lines 66-67 and col. 4, lines 24-26). Both the scanner 114 and the back-end sub-system 126 are in the main housing of the ultrasound system 100 (col. 4, lines 24-26 and 45-46). In the separate transducer assembly, partial beamforming is provided (col. 4, lines 6-23). The transducer assembly outputs the partially beamformed information to the main housing of the ultrasound system 100, where analog-to-digital converters 116 convert the partial beamsums into digital data (col. 4, lines 24-31; and Figure 1). In Newman, the data in the transducer assembly is in a form usable by the scanner. The scanner receives incoming analog signals and then converts the signals within the main housing of the ultrasound

system for further beamforming. Newman does not convert the processed signals in the transducer assembly.

Both Newman and Okado output from the transducer without conversion. The ultrasound scanning system is designed to work with the signals output by the transducer assembly.

Independent claim 9 recites a transducer assembly comprising a connector housing at least partially enclosing a detachable connector and a signal processing device.

Newman and Okado do not disclose these limitations. Okado provides for detachable connection of the transducer assembly. Okado provides a probe side connector 33, but without any electronics or processor (col. 3, lines 17-18). Newman shows a probe end of the transducer assembly including a partial beamformer (Figure 1; and col. 4, lines 6-23). The transducer assembly 114 connects with the main housing of the ultrasound system 100 (col. 4, lines 24-26 and 45-46). Newman does not show a probe side connector, but instead shows a cable connected to the main housing (Figure 1). Newman does not disclose a transducer assembly comprising a connector housing at least partially enclosing a detachable connector and a signal processing device.

The Examiner cites to component 114 as the connector housing. However, component 114 is the scanner, not the connector housing (col. 4, lines 24-25; and Figure 1). The scanner 114 is part of the main housing of the system 100, so is not a connector housing operable to disconnect from the system.

The Examiner mentions it would have been obvious to move the partial beamformer to the connector housing. However, a person of ordinary skill in the art would not have done such repositioning. The partial beamformer is necessary to reduce the number of cables to a realistic number. Moving the partial beamformer would result in an unrealistic number of cables from the transducer, so a person of ordinary skill in the art would not have done this.

Independent claim 16 recites converting partially beamformed signals to a different form appropriate for the ultrasound system, the conversion being performed in the transducer assembly. As noted by the Examiner, Savord does not disclose conversion in the transducer assembly. The Examiner alleges it would have been obvious to convert in the transducer assembly since different packaging configurations may be used and moving conversion

would have been routine skill. However, it would not have been obvious due to limitations on placing electronics in transducer assemblies. As noted by Savord, it is not feasible to incorporate all the circuitry into the transducer scan head (col. 2, lines 1-4). Power, cost and size are all issues for putting electronics in the transducer assembly (col. 2, lines 5-8). Savord places the sub-array processors in the transducer assembly for a necessary purpose, to reduce the 3,000 cable count down to the realistic 120 (col. 5, lines 45-55). The transmit/receive switch is eliminated in the interests of saving power and reducing complexity (col. 5, lines 57-59). A person of ordinary skill in the art would not have added conversion circuits to the transducer assembly since such circuits would have increased the size, power, cost and heat. Analog-to-digital converters are relatively large, use substantial power, and generate heat, so a person of ordinary skill would not have added conversion to the transducer assembly. Adding such conversion circuits to a transducer assembly is based on hindsight reasoning. Given the teachings of Savord to minimize size, power, and cost in the transducer assembly, a person of ordinary skill in the art would have put the needed partial beamformer but not the conversion circuit in the transducer assembly.

Savord discloses that “different packaging configurations may be utilized within the scope of the present invention” (col. 6, lines 54-56). This sentence is at the end of a paragraph describing the location of components of the transducer assembly within the transducer assembly. A person of ordinary skill in the art would understand the teaching to be for different packaging of the listed components within the transducer array, not the unrelated distribution of components between the transducer assembly and the imaging system.

Independent claim 22 recites digital-to-analog conversion of signals or mixing of signals within the detachable connector. Newman and Okada do not show conversion even in the transducer assembly as noted above for claim 1. The cited references do not disclose conversion in the detachable connector.

Dependent claims 2-7, 10-12, 14-15, 17, 19-21, and 23-24 depend from one of the independent claims, so are allowable for the same reasons as the respective base claim. Further limitations patentably distinguish from the cited references.

Claim 4 recites partially beamforming demultiplexed signals. The Examiner cites to the mux/demux 18/418 of Pflugrath, et al. However, the mux/demux is used as a multiplexer for receive operation (col. 6, lines 55-59). Pflugrath, et al. do not disclose beamforming of demultiplexed signals. Claim 14 is allowable for similar reasons.

Claim 5 recites converting digital to analog signals in the transducer assembly. As noted by the Examiner, Newman and Okado do not disclose this conversion. Instead, Newman converts analog signals from the transducer to digital signals in the system. It would not have been obvious to provide digital to analog conversion as suggested by the Examiner since transducers generate analog signals. If the system were analog, there would have been no reason to provide any digital processing, even in the transducer assembly. Claim 11 is allowable for similar reasons.

Claim 6 recites that the converting is mixing. Newman does not disclose mixing in the transducer assembly. Claim 12 is allowable for similar reasons.

Claim 7 recites processing in the transducer probe housing and converting within a connector housing releasable from the ultrasound system, a cable connecting the transducer probe housing with the connector housing. Newman does not disclose any processing in the connector housing. Claim 19 is allowable for similar reasons.

Claims 15 and 23 recite conversion to a form appropriate for the ultrasound system, so are allowable for the same reasons as claim 1.

Claim 17 recites sub-array mixing. Savord subarray beamforms. The subarray beamforming uses amplifiers, a summing node, a phase shifter, and a summing unit (see Figure 5). Sub-array mixing is not disclosed.

CONCLUSION:

Applicant respectfully submits that all of the pending claims are in condition for allowance and seeks early allowance thereof.

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